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ABSTRACT

Using an effort toward comprehension paradigm developed by P. M. Auble, J. J. Franks, and S. A. Soraci, Jr. (1979), the worry component of state test anxiety was related to long-term memory for sentence encoding conditions that involved comprehension, but low effort (embedded-cue) and comprehension-high effort (post-cue). A noncomprehension control condition (no cue) was also included. Data from 84 female undergraduates in six experimental conditions were analyzed. The results indicated that worried students performed more poorly, but that effortful comprehension produced the same pattern of beneficial recall effects for both low and high worry students. Apparently, cognitive effort involved with sentence comprehension led to superior performance in both free recall and cued recall, independent of worry. (Author/DWH)

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Test Anxiety and Effort-Toward-Comprehension in Sentence Memory

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Abstract

Using an effort-toward-comprehension paradigm developed by Auble, Franks, and Soraci (1979), the worry component of state test anxiety was related to long-term memory for sentence encoding conditions that involved comprehension, but low effort (embedded-cue) and comprehension - high effort (post-cue). A noncomprehension control condition (no cue) was also included. The results indicated that worried students performed more poorly, but that effortful comprehension produced the same pattern of benefical recall effects for both low and high worry students. Apparently, cognitive effort involved with sentence comprehension led to superior performance in both free recall and cued recall, independent of worry.

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Test Anxiety and Effort-Toward-Comprehension in Sentence Memory

In the test anxiety literature, an impressive body of evidence suggests that the detrimental effects of test anxiety upon learning and memory exist, and can be linked to positive relationships between the "trait" of test anxiety and state anxiety (worry, but not emotionality) experienced by students, and negative relationships between experienced worry and levels of task performance (Sarason, 1972, 1980; Krohne & Laux, 1982; Schwarzer, van der Ploeg, & Spielberger, 1983; van der Ploeg, Schwarzer, & Spielberger, 1983, 1984). The relationships are particularly robust under conditions of evaluative stress and failure, and appear from elementary through college (Sarason, 1980). Test anxiety is an active, applied research area with approximately 100 - 150 publications appearing per year in ERIC, Dissertation Abstracts, and Psychological Abstracts across the 1980 - 1984 period.

The effects of emotional states upon memory are currently receiving a great deal of attention in the general experimental literature on memory and cognition as well (e.g., Bower, 1981; Leight & Ellis, 1981). For example, the 17th Annual Carnegie Symposium on Cognition in 1981 dealt entirely with the interface between affect and cognition for only the second time in its history (Clarke & Fiske, 1982). There is now considerable evidence that variables related to

emotional state can influence the efficiency of mnemonic functioning (See Eysenck, 1982; Hasher & Zacks, 1979) as well as qualitative aspects of such functioning (See Bower, 1981). However, we still know little concerning the principles which govern the appearance of such effects or of the mechanisms through which they occur (e.g., organization, elaboration, distintiveness, effort, etc).

Within the memory area specifically, some recent evidence indicates that the use of effortful processes at input is associated with superior memory in subsequent tests (e.g., Tyler, Hertel, McCallum, & Ellis, 1979; but see Zacks, Hasher, Sanft, & Rose, 1983). The general finding appears that those memory processes most beneficial to memory require large amounts of effort (Eysenck & Eysenck, 1979). It also appears that affect can influence such effortful processes. For example, Ellis, Thomas, and Rodriquez (1984) evaluated the effects of experimentally-induced depression on sentence processing and recall. They found that high-effort sentences led to increased recall in comparison to low-effort ones. But, the effects were lost with the depressed mood subjects. They interpreted this latter finding to indicate that depressed subjects may allocate fewer resources to the difficult task than were allocated under neutral or normal mood conditions.

There still seems to be some ambiguity over the effects of cognitive effort vs. cognitive strategy used by the subjects. We still lack basic information concerning the relationship of emotional processes to cognitive strategies and to the

effects of effort per se on memory performance. Part of the effects noted by Ellis et al. (1984) may reflect differences in recall performance related to different strategies employed by the high and low depressed subjects as opposed to those related solely to cognitive effort. Some evidence from our research has indicated that imagery and semantic strategies, for example, may result in different performance of low and high depressed subjects. In the present research, however, we wished to evaluate test anxiety effects in a situation in which strategy differences between different students are unlikely.

In the domain of sentence memory, Auble and Franks (1978) and Auble, Franks, and Soraci (1979) developed a paradigm that presents an attractive one to consider since it appears to provide some control over strategy. These authors have shown that the free recall of difficult-to-interpret sentences is improved under conditions in which subjects actively attempt to interpret the sentences, as opposed to conditions in which "cues" for the correct interpretation are embedded within the sentence itself. That is, both comprehension of the sentences and effort expended in forming this comprehension have independent, facilitative effects on memory.

Consider, for example, the following sentence which is similar to those used by Till (1977) in the study of inferencing from sentences: "The haystack was important because the cloth ripped." This difficult-to-interpret

sentence could be presented as is (no cue) or with a cue embedded within it to make it comprehensible (and low effort) such as "The haystack was important because the cloth of the parachute ripped." Or this sentence could be presented in a high-effort mode with the cue "parachute" being presented 5 sec after the initial presentation of the core sentence. Data from a number of experiments by Auble and her colleagues indicated that free recall performance was higher in the delayed-cue condition (high effort) than in the embedded-cue (low effort) suggesting that "effort-toward-comprehension has a positive effect on memory performance independent of comprehension. They also found that cognitive effort was not beneficial unless comprehension of the sentences was ultimately achieved.

In the present study we questionned whether effort-toward-comprehension is lessened by worry, the major ingredient for test anxiety theorists who favor an "interference model." Our predictions were straightforward. If worried students have less task available processing capacity, they may exhibit deficiency in effort-toward-comprehension of sentences. That is, they may fail to show superiority of the post-cue condition over the (low effort) embedded-cue condition in free recall. As a consequence, the detrimental effects associated with worry should be stronger in the and post-cue condition than in the (low effort) embedded-cue condition. In addition to potential differences attributable to effort, a basic deficit in comprehension between the high and low worry students might be shown in the control

condition where cues are not provided during input.

Although these predictions pertained to free recall performance, we also were interested in cued recall in response to inference cues. If effort-toward-comprehension is a factor in cued recall, we should find better performance in the post-cue condition than in the embedded-cue condition, though perhaps only with the low-worry students. To our knowledge, prior research has not examined effort-toward-comprehension in inference cued recall.

A subsidiary question addressed in this experiment concerned the impact of imagery on sentence comprehension and recall. In our prior work some evidence was found to suggest that an imagery strategy led to better sentence recall compared to semantic strategies or other rote strategies (Hedl & Bartlett, 1982) and might interact with level of depression. We therefore compared a semantic encoding strategy (determine the gist of the sentence) with a semantic plus imagery one using a between subjects design.

METHOD

Subjects

Subjects were 84 female volunteers from introductory psychology classes at a metropolitan university who received course credit for their participation. They were randomly assigned to the six experimental conditions: strategy (semantic vs. semantic plus imagery), input list (3 counterbalanced versions). For the statistical analyses

students were classified into high, mid, and low test-anxious groups based upon thirds of the worry subscale of the revised Worry-Emotionality Questionnaire (WEQ: Morris, Davis, & Hutchings, 1981). The experiment was run in small groups of 6 - 8 students.

Materials and Procedures

The experiment was conducted using a set of 27 sentences; 18 of which were used in previous experiments (Hedl & Bartlett, 1981, 1982), and 9 selected from Auble et al. (1979). The first and last two sentences in the list were filler items designed to reduce primacy and recency effects in the target list of 24 sentences and were not used in the statistical analyses. One-third of the sentences were not presented with a cue, and one-third had the cue embedded in the sentence. The remaining one-third were presented with a cue after a 5 sec delay.

Consider, for example, the following sentence: "The haystack was important because the cloth ripped." In the no-cue condition this sentence would be presented alone. In the post-cue condition this sentence would be followed - after a 5 sec delay - by the cue, "parachute." In the embedded-cue condition the sentence would be modified as follows: "The haystack was important because the cloth of the parachute ripped." The three types of sentences were randomly intermixed during the initial presentation. Three different input lists were formed and counterbalanced such that each sentence appeared with no cue, with an embedded cue, or with a post cue in equal numbers in both the imagery and semantic

orienting task conditions.

Students were told that the sentences would vary in their comprehensiveness and that some of the sentences would be followed by a word which might help them to understand the sentence. Students in the imagery condition were given additional instructions to develop a picture of the sentence situation or event that incorporated all of the major objects included in the sentence. Two example sentences were then presented in both encoding task conditions.

After presentation of each sentence-cue combination and the 5 sec delay, the experimenter said "Mark," and the students rated whether they understood the sentence, did not understand the sentence, or were unsure whether they understood the sentence or not. They were given 2 sec to rate each sentence before the next sentence was presented.

Immediately after the sentences were presented, a writing speed task was administered. Beginning with the number 100, students were instructed to write as many numbers they could in backwards order (e.g., 100, 99, 98, etc.) within a one-minute period. They were then given 5 minutes to free recall as many of the sentences as possible.

An inference cued recall test was then administered in which the cues were presented and students were to recall the sentence to which the cue referred. Parachute would be the inference cue for the example sentence. One-half of the first 12 target sentences were tested in the first half of the test, one-half in the second part of the test and vice

versa. Sentences were randomly assigned to the test halves. Then they were randomly assigned to order within test half with the stipulation that a run of no more than two consecutive sentences from either half could occur.

Following cued recall students completed the WEQ with instructions to indicate their feelings during the experiment. All students were then debriefed and given the opportunity to ask questions about the experiment.

The cued recall sentence responses were scored in terms of the lenient criteria established by Till (1977) and Till, Cormack, and Prince (1977).[2] That is, sentences were scored correct if they were recalled verbatim, synonymous substitutions or omissions of partially redundant information, or specified the agent, verb, and some of the additional information. Reliability of two raters was .98 and .97 for the free and cued recall data, respectively for a subset of the sentence data.

RESULTS

All ANOVA analyses included the between subjects variables of worry (high, mid, low), and encoding strategy (semantic, semantic plus imagery) with type of sentence cue (none, post, embedded) as a within subjects variable. Tables 1 and 2 present the means and standard deviations of the comprehension self-ratings, free recall, and inference cued recall as a function of worry level and encoding strategy.

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Insert Tables 1 and 2 about here

Encoding Comprehension Ratings

The influence of worry and encoding strategy on sentence comprehension was studied using the number yes responses as an index of "comprehension." This 3 x 2 x 3 ANOVA indicated a main effect for level of worry ($F(2,78) = 6.24$, $p < .004$); a strategy (semantic vs. semantic plus imagery) main effect ($F(1,78) = 8.56$, $p < .005$); and type of cue main effect ($F(2,156) = 149.21$, $p < .005$). Newman-Keuls' analysis indicated that the high (Mean = 75%) and mid-worry students (Mean = 80%) showed similar self ratings for comprehension, but that both groups indicated lower ratings than the low-worry students (Mean = 85%).[3] Similarly, post-cue (Mean = 92%) and embedded-cue sentences (Mean = 91%) were associated with equivalent comprehension ratings while both were superior to the ratings for the no cue sentences (Mean = 58%). The strategy main effect indicated that the imagery encoding strategy was associated with higher comprehension ratings (Mean = 83%) than the semantic strategy (Mean = 77%). A significant strategy x type of cue interaction was found ($F(2,156) = 7.11$, $p < .002$), but it did not modify the main effect for worry.

Free Recall Memory Performance

The number of sentences recalled correctly in free recall was analyzed as a function of worry, strategy, and type of cue. The ANOVA indicated a significant main effect for level

of worry ($F(2,78) = 4.81$, $p < .02$) and for type of sentence cue ($F(2,156) = 63.17$, $p < .001$). Post hoc analyses indicated that the high worry students (Mean = 22%) had significantly lower performance than the lows (Mean = 31%) while the mid group (Mean = 26%) did not differ from either extreme group. And the post-cue condition (Mean = 41%) had the highest memory performance in comparison to either the no cue (Mean = 20%) or embedded-cue condition (Mean = 18%), the later two groups not differing from each other.

Contrary to our expectation, no interactions between worry and cue conditions were found. Nor was the main effect for encoding strategy significant.

Inference Cue Memory Performance

The inference cue test data were analyzed in a similar manner. Only main effects for level of worry ($F(2,78) = 9.72$, $p < .0002$) and type of cue ($F(2,156) = 173.59$, $p < .00001$) were found. Post hoc analyses indicated that the high (Mean = 63%) and mid worry groups (Mean = 69%) showed similar levels of cued recall performance and were both significantly lower than the low-worry students (Mean = 80%). The post-cue condition (Mean = 85%) was again superior to the embedded-cue one (Mean = 80%), while both were superior to the no cue condition (Mean = 47%). We note, however, that in cued recall the difference between post-cue and embedded-cue performance was relatively small (5%) compared to a 23% difference found in free recall.

A subsidiary 3 x 2 ANOVA, collapsed across encoding strategy, examined the reliability of worry effects for just

the post- and embedded-cue sentences. The cue main effect was again reliable ($F(1,81) = 4.98$, $p < .03$) as was the worry main effect ($F(2,81) = 5.15$, $p < .008$). The interaction was not significant.

DISCUSSION

The results of this study demonstrate the presence of reliable test anxiety effects related to state worry in sentence comprehension and memory. They also show that effort-toward-comprehension has facilitative effects on both free recall and cued recall. But the results fail to support the hypothesis that effort-toward-comprehension is a process involved in producing test anxiety effects. Low test-anxious students appeared to expend effort-toward-comprehension in that their post-cue sentence performance was higher than their embedded-cue performance in both free and cued recall. But exactly the same pattern was demonstrated by the high test-anxious students. The general superiority of the low test-anxious students merely indicates that they were better than the highs in all experimental conditions.

Theoretically, there may be several possible explanations for these findings. First, it is quite possible that effort-toward-comprehension is not a key feature for understanding test anxiety effects in sentence memory. The combination of a state of noncomprehension, followed by effort and understanding (post-cue condition) may involve a robust set of memorial processes that are not easily influenced by

emotional states such as worry. Second, perhaps the post-cue/embedded cue difference is not due to any effort mechanism at all, but involves some other memory processes. This interpretation is consistent with other evidence that the relation between cognitive effort and memory may be less robust than once thought (Zacks et al., 1983). But, our findings along with those of Auble and her colleagues lead us to believe otherwise.

The data clearly indicate that worry reduces memory performance in all three encoding conditions (noncomprehension, comprehension - low effort, comprehension - high effort) and in both free recall and cued recall. The worry effect was also independent of an attempted manipulation of encoding strategy (semantic vs. semantic plus imagery). What mechanism (s) can then explain the general negative effects of worry across all conditions? One common denominator may be that high test-anxious students are deficient in encoding processes related to comprehension per se. Regardless of experimental conditions, they do not develop as full or complete an understanding of the sentences as do low test-anxious students, and consequently recall and recognition are affected. The worry effect on self-rated comprehension supports this view.

Another possibility may be that these three tasks require a working memory component. If worry interferes with working memory as others have suggested, and if the process of encoding sentences depends on working memory, then performance would be expected to be lower in worried

students, regardless of test condition (Eysenck, 1982; Mandler, 1975, 1982; Mueller, 1980). Along similar lines, cognitive-attentional test anxiety theory suggests that the major locus of the effect concerns an attentional mechanism, and assumes a limited capacity information processing system (See Wine, 1971, 1980, 1982 for summaries of this literature).

The results of the study have some implications from the perspective of general theories of memory. In their initial investigations of effort-toward-comprehension, Auble et al. (1979) concluded that the combination of comprehension plus effort in forming that comprehension facilitated sentence memory because it resulted in a distinctive memory trace as opposed to an elaborated one. The present results might question this view. Performance in the embedded-cue condition, relative to that in the post-cue and no cue conditions varied as a function of type of test.

In free recall, post-cue performance was superior to embedded-cue and no cue performance which did not differ. But in cued recall, post-cue performance was only slightly superior to embedded-cue performance (5%) while both were superior to no cue performance. The suggestion of this pattern is that effortful comprehension, as opposed to automatic comprehension, is more important for free recall than cued recall. Given other findings that elaboration is especially useful in tests like free recall (Jacoby & Craik, 1979), we are led to consider the notion that effortful

comprehension leads to a more elaborated trace. In contrast, automatic comprehension leads to a distinctive, but unelaborated trace. Of course, additional research data is needed to support this possibility. But in general, the data suggest that effort-toward-comprehension affects the memory trace qualitatively, and not just quantitatively.

On the other hand, these data suggest a quantitative effect of the state worry component of test anxiety in sentence memory and recall, and not a qualitative one related to effort-toward-comprehension. Worry appears to impact a memory resource common to many tasks and conditions, and one that may relate to working memory although comprehension differences may be implicated as well. The results further suggest that considerable research is necessary to determine the conditions under which test anxiety (or other emotional states such as depression) affect the efficiency of memory processes, the choice or usage of cognitive strategies, or both (Ellis et al., 1984). It is probable, however, that a complete theory of test anxiety and cognition will need to embrace an array of encoding and retrieval processes, and any one mechanism will not emerge as the defining feature of the problem.

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Author Notes

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Requests for copies of the paper should be directed to John J. Hedl, Jr., Department of Allied Health Education, School of Allied Health Sciences, The University of Texas Health Science Center at Dallas, 5323 Harry Hines Blvd., Dallas, Texas 75235.

Footnotes

1. In general, level of test anxiety as measured by the Test Anxiety Inventory (TAI: Spielberger, 1980) was unrelated to memory performance in this study and generally in the previous studies using similar sentence materials and procedures. Only the state measures of test anxiety (primarily worry) were found to be significantly associated with performance.

2. Analyses were also run using a strict scoring criterion for sentence recall and the same pattern of results was found in both free recall and cued recall. As to be expected, strict scoring led to lower scores for all students.

3. All post hoc analyses involved the Newman-Keuls' multiple-range procedure, .05 level of significance unless otherwise noted in the text.

Table 1

Means and Standard Deviations of Comprehension Ratings as a Function of Level of Worry, Encoding Strategy, and Type of Sentence Cue

	Level of Worry					
	Low		Mid		High	
	Mean	SD	Mean	SD	Mean	SD
Encoding Ratings						
Imagery						
No Cue	6.00	1.35	5.12	1.96	4.69	2.01
Post-Cue	7.69	.63	7.31	1.20	7.23	.83
Embedded-Cue	7.62	.51	7.25	.86	7.15	.80
Semantic						
No Cue	4.60	1.68	3.75	1.95	3.54	1.69
Post-Cue	7.53	.74	7.31	.60	7.18	.87
Embedded-Cue	7.53	.52	7.50	.63	6.36	1.57

* Based upon 8 sentences per cue condition.

Table 2

Means and Standard Deviations of Free Recall and Cued Recall as a Function of Level of Worry, Encoding Strategy, and Type of Sentence Cue

	Level of Worry					
	Low		Mid		High	
	Mean	SD	Mean	SD	Mean	SD
Free Recall						
Imagery *						
No Cue	2.15	1.21	1.50	.82	1.15	.90
Post-Cue	4.08	1.19	3.18	1.52	2.85	.99
Embedded-Cue	1.77	1.24	1.69	1.40	1.00	.91
Semantic						
No Cue	1.80	1.21	1.50	1.41	1.36	1.29
Post-Cue	3.20	1.74	3.06	1.69	3.45	1.37
Embedded-Cue	2.00	1.46	1.31	1.08	.91	.94
Inference Cue Recall						
Imagery						
No Cue	4.92	.61	3.50	1.63	2.69	1.25
Post-Cue	7.62	.65	7.12	1.15	6.31	.85
Embedded-Cue	7.23	1.01	6.56	1.26	5.85	2.19
Semantic						
No Cue	4.80	1.58	3.44	1.41	3.09	2.02
Post-Cue	7.33	1.05	6.12	1.67	6.18	2.27
Embedded-Cue	6.67	1.45	6.19	1.60	6.00	1.79

* Based upon 8 sentences per cue condition.

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